IN THE SPECIFICATION:

Page 1, immediately following the title, please insert the following:

This is the U.S. national phase of International Application No. PCT/GB03/02917 filed July 7, 2003, the entire disclosure of which is incorporated herein by reference.

On page 1, after the title please insert headings as follows:

BACKGROUND

Field of the Disclosure

The paragraph beginning on page 1, line 2 has been changed as follows:

The ~~present invention~~ disclosure relates to a method for patterning a device layer and to devices made using the method. The ~~invention~~ disclosure is particularly concerned with a method for patterning an optoelectronic device layer that is simpler and more cost effective than previously known methods.

On page 1, after line 6 please insert a heading as follows:

Related Technology

The paragraph beginning on page 1, line 7 has been changed as follows:

One class of optoelectronic device that is of particular interest ~~of the present invention~~ is an organic light-emitting device (OLED). These devices employ an organic material for emission.

The paragraphs beginning on page 2, line 3 have been changed as follows:

Organic light emitting devices (~~OLED's~~ OLEDs) which make use of thin films of polymer are becoming an increasingly popular technology for applications in devices comprising a plurality of OLED pixels arranged to form a display, such as a flat panel display (FPD). Such an OLED including a pixel arrangement typically comprises a plurality of luminescent pixels that are arranged in a matrix form.

To form an array of ~~OLED's~~ OLEDs, constituent materials must be patterned. A pixelated OLED device includes, for example, a plurality of first electrode strips formed on a substrate. The strips are arranged in a first direction. One or more organic layers are formed on the first electrode strips. A plurality of second electrode strips is formed over the organic layers in a second direction that typically is orthogonal to the first direction. The intersections of the first and second electrode strips form pixels.

The paragraph beginning on page 4, line 21 has been changed as follows:

A replica ~~moulding~~ molding (soft embossing) technique is ~~summarised~~ summarized in Figure 1 of Advanced Material 2000, 12 No. 3 page 189 to 195. A patterned elastomer is put in conformal contact with an active polymeric film area and the assembly is brought to the polymer softness transition temperature. After cooling, the patterned elastomer stamp is removed and leaves the grating pattern on the polymer surface. This technique also is generally described in Figure 3(A) of Chemical Reviews 1999, Vol. 99 No. 7 page 1823 to 1848.

On page 8, after line 17 please insert a heading as follows:

DISCLOSURE

The paragraphs beginning on page 8, line 18 have been changed as follows:

Therefore, it is an object of the ~~present invention~~ disclosure to provide a simplified but effective method for patterning a device layer.

Accordingly, in a first aspect of the ~~present invention~~ disclosure, there is provided a method for patterning a device layer using a patterned stamp comprising steps of:

(1) providing a substrate;

(2) bringing the patterned stamp into contact with the substrate

(3) removing the patterned stamp;

characterised in that step (2) is carried out so that the surface energy of the substrate is modified in accordance with the pattern; and that the method further comprises a step; and

(4) depositing a solution of a device layer on the substrate after the patterned stamp has been removed; whereby the surface energy of the substrate determines the deposition pattern of the device layer.

The paragraphs beginning on page 9, line 14 have been changed as follows:

It will be appreciated from the above that, in step (2) of the method according to the first aspect of the ~~present invention~~ disclosure, bulk material is not transferred either from or to the surface of the patterned stamp. This has a clear advantage over known soft lithography methods that use a patterned stamp and where bulk material is transferred from or to the patterned stamp in the soft lithography method. Namely, in the present method, the patterned stamp will not be contaminated during use. Thus, the patterned stamp can be used again and, more specifically, can be used again without subjecting it to costly and yet somewhat still unreliable cleaning methods. A further advantage is that the surface of the substrate also is not contaminated during the method.

In contrast with some soft lithographic methods, it will be understood also that the patterned stamp per se is brought into contact with the substrate in the method according to the first aspect of the ~~present invention~~ disclosure. In most soft lithography methods, the stamp is not brought into direct contact with the substrate. Instead, a layer of device layer material always is interposed between the stamp and the substrate. In the ~~present invention~~ disclosure the stamp is brought into direct contact with the substrate with no intervening layer of material between the stamp and the substrate and with no bulk transfer of material between the stamp and the substrate. As compared with some soft lithography methods, it will be appreciated readily that any problems of incompatibility between the stamp material and device layer solvent are obviated in the present method because the device layer is deposited after the patterned stamp has been removed.

The paragraphs beginning on page 10, line 18 have been changed as follows:

Further, it will be appreciated that no banks are needed in the method according to the first aspect of the ~~present invention~~ disclosure. This is because the deposited device layer is confined to portions of the surface of the substrate by virtue of the difference in surface energy between these portions and the remainder of the surface of the substrate. The ability to omit the use of banks in the method according to the first aspect of the ~~present invention~~ disclosure greatly simplifies the method and, thus, makes it more time and cost effective. The ~~present invention~~ disclosure provides an alternative and much more simple solution to at least some of the problems of previously known methods.

For the purposes of the ~~present invention~~ disclosure, the term "patterned stamp" may be taken to mean a stamp having one or more protruding elements such that when the patterned stamp is brought into contact with the substrate in step (2), the one or more protruding elements are in contact with the surface of the substrate and one or more

indentations (between the one or more protruding elements) will not be in contact with the surface of the substrate.

For the purposes of the ~~present invention~~ disclosure, the term "device layer" may be taken to encompass any layer of material suitable for inclusion in an electrical, mechanical or electromechanical device. As such, layers of bank material are intended to be encompassed by this term.

In the ~~present invention~~ disclosure, "surface energy" is measurable by contact angle measurements. Generally, contact angles are measured on model surfaces.

In the ~~present invention~~ disclosure, preferably, the patterned stamp is a patterned elastomer. As such, any reference to a patterned stamp in the context of the ~~present invention~~ disclosure preferably is a patterned elastomer.

The paragraphs beginning on page 17, line 17 have been changed as follows:

According to the first embodiment of the first aspect of the ~~present invention~~ disclosure, the patterned stamp has a function to modify the surface energy of the substrate, typically a film formed from aqueous solution. No additional surface energy modifying process is needed. As the patterned stamp is applied on a substrate surface for a time period it can turn some surfaces from high surface energy to low surface energy and can turn other surface from low surface energy to high surface energy. The change in surface energy is attributed to the interaction between the stamp surface (usually elastomer molecules) and the substrate surface. The formation of either a positive pattern or a negative pattern can be understood by the requirement of minimization of free energy of whole system. Surface energy directs liquid to the high surface energy area where contact angle is lower. Liquid easily wets and spreads over the area and finally deposits on the hydrophobic area after the solvent evaporates. A pattern generated in a positive or a negative manner with respect to the

patterned stamp depends on modification effect. A positive pattern can be formed when the patterned stamp modifies a surface from low surface energy to high surface energy. A negative pattern can be generated when the patterned stamp modifies a surface from high surface energy to low surface energy. Patterning of polymer on a modified PEDOT-PSS surface by spin coating, for example, demonstrates the very strong adhesive force between polymer solution and high surface energy area. The larger difference in surface energy or in contact angle is indeed a crucial rule for the patterning procedure.

It will be appreciated that the stamp material may be selected so as to ~~optimise~~ optimize the surface energy modifying effect in the first embodiment of the present method. In this embodiment, it is preferred that the stamp is an elastomer and a particularly preferred elastomer is poly(dimethylsiloxane)(PDMS) and equivalents thereof. PDMS is solvent resistant and is soft and flexible with a low surface energy such that it may easily be removed from the substrate. Further, it has been found that particularly good resolution can be obtained using PDMS as the patterned elastomer. Specifically, resolution has been found to improve threefold over previous photolithography methods for patterning a device layer.

The paragraph beginning on page 20, line 12 has been changed as follows:

In the second embodiment, ~~O_2/CF_4~~ O_2/CF_4 plasma treatment may be carried out in a RF barrel etcher of dimensions about 300mm diameter, about 450mm depth, with a gas mixture of about 0.5-2% CF_4 in oxygen, at a pressure of about 1.5 Torr and a power of about 400 W. The treatment suitably is carried out for about 10-30 s. In the case of exposure to UV radiation, the UV light source may be an Ushio UER 200-172 lamp providing 7mW/cm^2 at a wavelength of 172 nm. Suitably, the UV light source may be positioned about 1.1mm from the substrate. The treatment suitably is carried out for about 15 s.

The paragraphs beginning on page 20, line 33 have been changed as follows:

In a second aspect according to the present invention, there is provided a method for making an electrical, mechanical, or electromechanical device including a method according to the first aspect of the ~~present invention~~ disclosure.

In this second aspect of the ~~present invention~~ disclosure, the substrate provided in step (1) typically will be supported by one or more further device layers, at least one of which may be a patterned device layer. Also, typically, the method according to the second aspect of the ~~present invention~~ disclosure will include a further step (5) of depositing on the device layer deposited in step (4) one or more further device layers.

The paragraphs beginning on page 21, line 14 have been changed as follows:

An important pixelated OLED device is a flat panel display (FDP). The FPD may be used in products including cellular phones, cellular smart phones, personal ~~organisers~~ organizers, pagers, advertising panels, touch screen displays, teleconferencing equipment, virtual reality products, and display kiosks.

The method according to the second aspect of the ~~present invention~~ disclosure provides a convenient way to build polymer microstructure for application in polymer microelectronics device, like passively addressed polymer light emitting diodes, (LEDs) displays, optically pumped micro-patterned polymer micro cavities and field effect transistors (FETs).

The paragraphs beginning on page 22, line 22 have been changed as follows:

In the above general method, it will be appreciated that a patterned stamp according to the ~~present invention~~ disclosure also may be used to pattern the anode and the cathode, provided that the anode or cathode can be deposited from solution. Also, it will be

appreciated that further device layers, other than those explicitly referred to, may be provided. The further device layers may be selected from hole transport layers and electron transport layers and also may be patterned using a patterned stamp according to the ~~present invention~~ disclosure.

The above method may be modified for the preparation of a ~~colour~~ color device. Instead of the patterned stamp being patterned so that parallel lines of spin-coated polymer are formed, the patterned stamp should be patterned so that the surface energy of the polymer is modified in accordance with a well or pixel structure. Red, Green and Blue light-emitting polymers then can be inkjet printed into the wells as required.

The paragraphs beginning on page 23, line 10 have been changed as follows:

The above descriptions of monochrome and ~~colour~~ color device structures are intended to be examples only. Those skilled in the art will readily appreciate modifications in accordance with this ~~invention~~ disclosure that could be made to these device structures.

According to a fourth aspect of the ~~present invention~~ disclosure, an electrical, mechanical or electromechanical device is provided as defined above in relation to the second aspect of the ~~present invention~~ disclosure. Suitably, the device may be obtained by the method according to the second aspect of the ~~present invention~~ disclosure. The device contains at least a patterned device layer supported on a substrate.

In devices according to the fourth aspect of the ~~present invention~~ disclosure, the surface of the substrate that is in contact with the patterned device layer is substantially flat, without relief features. This may be contrasted with some prior art devices where "banks" are used to create relief features on the surface of the substrate.

Regions of patterned device layer in devices according to the fourth aspect of the ~~present invention~~ disclosure are not separated by physical means.

On page 24, after line 16 please insert a heading as follows:

BRIEF DESCRIPTION OF THE DRAWINGS

The paragraphs beginning on page 24, line 17 have been changed as follows:

The ~~present invention~~ disclosure now will be described in more detail with reference to the accompanying drawings in which:

Figure 1 shows a cross section of a typical OLED device according to the ~~present invention~~ disclosure;

Figure 2 shows a typical OLED device known in the art using "banks";

Figure 3 shows the principle of surface energy controlled patterning according to the first embodiment of the first aspect of the ~~present invention~~ disclosure.

On page 25, before line 1 please insert a heading as follows:

Figures 1 and 2 clearly show the differences between a device according to the ~~present invention~~ disclosure and devices known in the art. In Figures 1 and 2, reference numeral 1 refers to a substrate; reference numeral 2 refers to an anode layer, usually ITO, that is patterned to form parallel lines running in the direction A-A'. Reference numeral 3 indicates a hole transport layer, for example PEDOT. Reference numeral 4 indicates a polymer device layer. Layer 4' is deposited by the method according to the first aspect of the present invention disclosure to form parallel lines orthogonal to the anode lines. Layer 4" is deposited between the banks 6. Reference numeral 5 indicates a cathode that is deposited over the polymer layer for example by shadow masking.

The paragraph beginning on page 25, line 27 have been changed as follows:

Following is the description and characteristic measurement of one processing procedure according to the first embodiment of the method according to the first aspect of the present invention disclosure.

The paragraphs beginning on page 26, line 14 have been changed as follows:

Modification of surface: To modify a film surface, the PDMS stamp is brought in conformal contact with the film surfaces. Samples are kept at room temperature and with ambient humidity. The contacting time of modification is [2] two days.

Poly (3, 4-ethylenedioxythiophene)-poly (styrenesulfonate) (PEDOT-PSS) and poly (sodium 4-styrenesulfonate) sodium salt (NaPSS) films are formed by spin coating from their aqueous solution. Standard PEDOT-PSS solution is a water dispersion (purchased from Bayer), 1.3% concentration in mass; NaPSS solution is prepared by dissolving compounds NaPPS (Aldrich), into deionized water with concentration of 1% in mass. The spinning speed to deposit above films is 3000 rpm and 2000 rpm, giving ~ 700Å thickness of these two films, respectively. The conjugated polymer film is formed on glass substrates with spin coating from organic solutions of the polymer, in which xylene, or chloroform is used as solvent. The concentration of the polymer solution is 1.4% in mass in general. Modifying these surfaces is done by bringing a flat or structured stamp in conformal contact with surface for time periods of up to [2] two days. Contact angle is determined as the stamp is removed from the modified surface.

The paragraph beginning on page 29, line 19 has been changed as follows:

The variation of height between the stamped area and not stamped area can be negligible except for the bulge line at the boundary of the stamped area, indicating that no

bulk material is transferred from the stamp to the surface during the process. The bulge may be caused by a larger interaction force between the patterned elastomer and the surface of substrate due to the higher pressure existing at the edge of the patterned elastomer contact area. It cannot be excluded that these bulges help in confining the polymer solution to certain areas in later processing steps. However, the AFM images ~~tell us~~ indicate that surface energy rather than topography directs the polymer solution to the desired areas.

The paragraph beginning on page 30, line 10 has been changed as follows:

The surface modification is done by bringing two flat stamps in conformal contact with PEDOT-PSS and NaPSS surface for [2] two days. After removing stamps the modified PEDOT-PSS and NaPSS surfaces are obtained. A Bruker IFS 113v FTIR spectrometer with a grazing angle accessory aligned at 85°-incidence angle is employed. In order to analyze the changes in chemical compounds on the surface modified by PDMS stamp, the IRAS of pure Au, PEDOT-PSS, NaPSS and modified PEDOT-PSS and NaPSS surface are measured.

The paragraph beginning on page 31, line 19 has been changed as follows:

Surface energy controlled patterning of polymer: The deposition and patterning of conjugated polymer on the modified PEDOT-PSS and NaPSS surface can be achieved by dip coating or spin coating from the organic solution. Photographs of polymer patterns deposited on these modified surfaces are taken by a reflective or an inverted transmission microscope equipped with a digital camera (Sanyo, ~~colour~~ color camera), under white light or under UV irradiation, The photoluminescence emission from conjugated polymer gives a high contrast image.